Detection of Reconnection Inflows with Solar-B/EIS

Solar-B/EIS によるリコネクションインフローの観測

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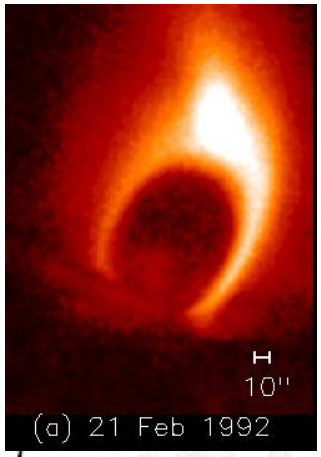
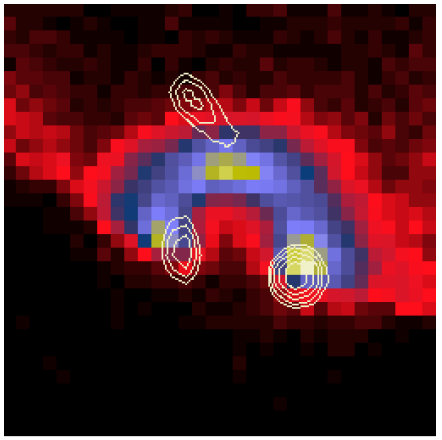
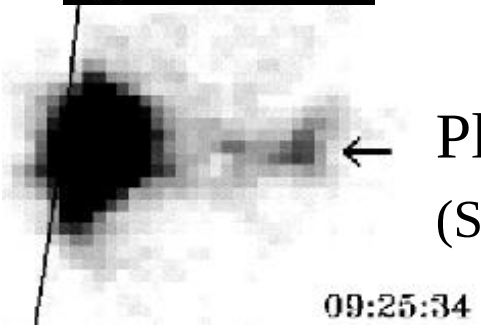
Evidence of reconnection from Yohkoh and SOHO



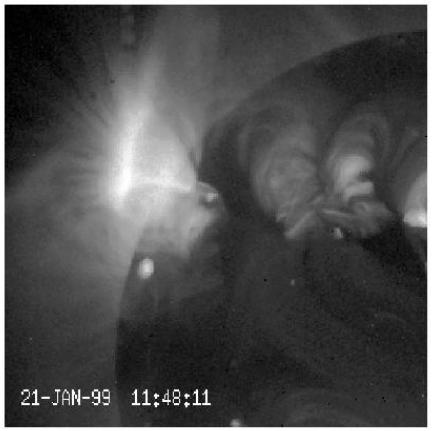
Cusp (Tsuneta et al. 1992)



Loop top HXR
(Masuda et al. 1994)

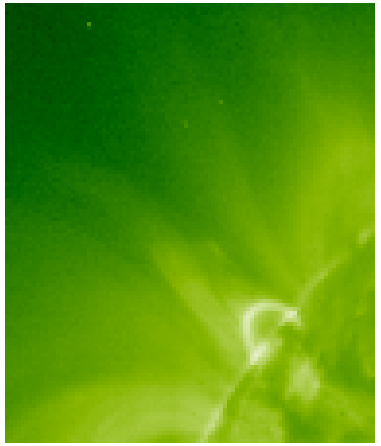


Plasmoid ejection
(Shibata et al. 1995, Ohyama and Shibata 1997, 1998)



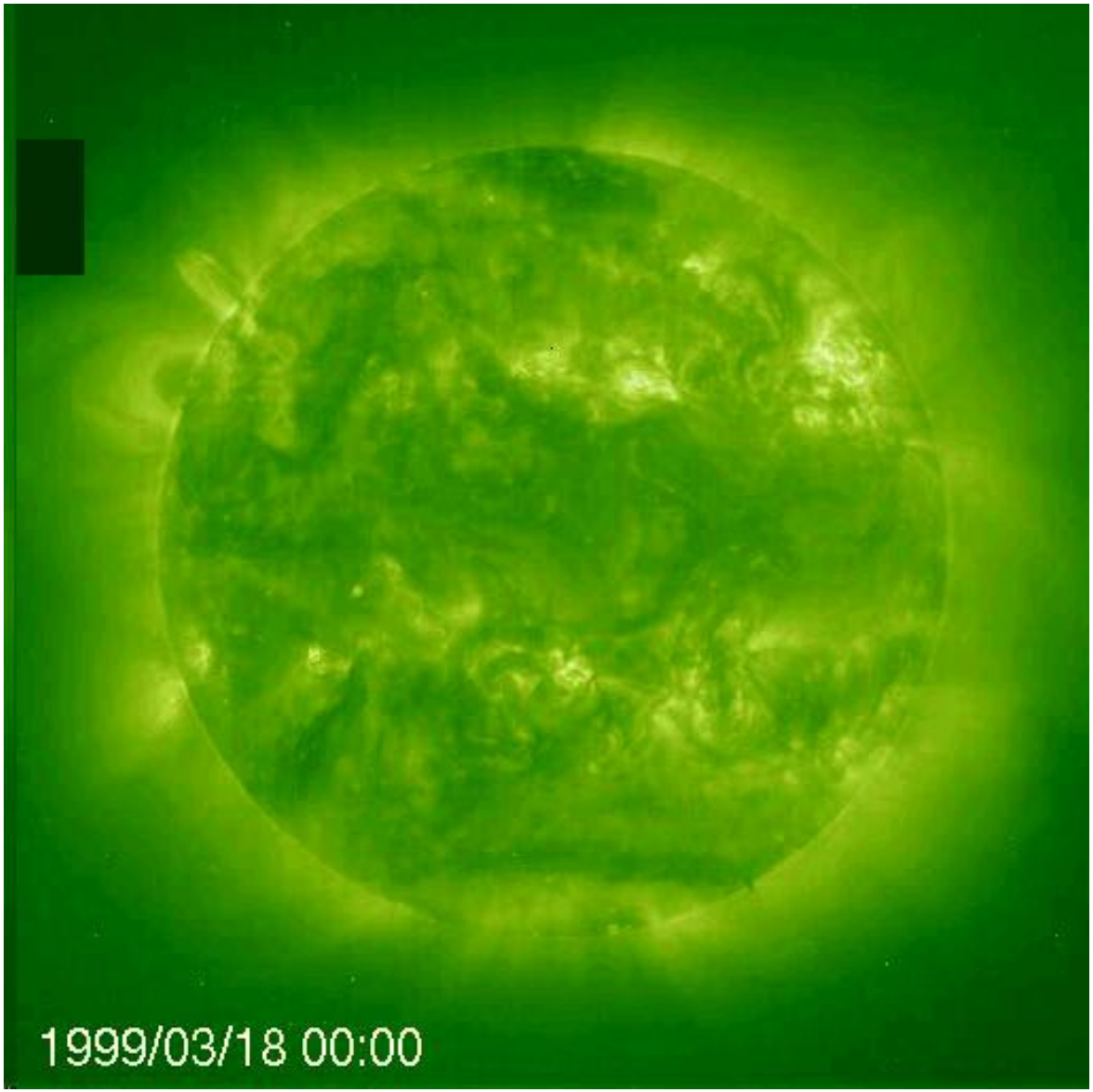
Down flow
(McKenzie and Hudson 1999)

Inflow
(Yokoyama et al. 2001)



Reconnection inflow (Yokoyama et al. 2001)

No Dopper shift detection has been done.



Why inflow

- More direct evidence of reconnection in flares
- Reconnection rate vin/vA is proportional to:
  - energy release rate
  - induced electric field => particle acceleration
- Basic physics of reconnection: Sweet-Parker or Petschek? Driven or Spontaneous?

Can EIS detect the inflow?

Inflow velocity:

-Yokoyama et al. (2001) ･･･ ～ 5 km/s

-Isobe et al. (2002) ･･･5-150km/s (inderect method)

-Velocity resolution of EIS～ 1-3km/s

=> possible?

Problem:

- Structure is complicated (and 3D).
- Velocity distribution is continuous.
- Simple fitting (such as 2 gaussian component) is not enough.
- VDEM is needed.

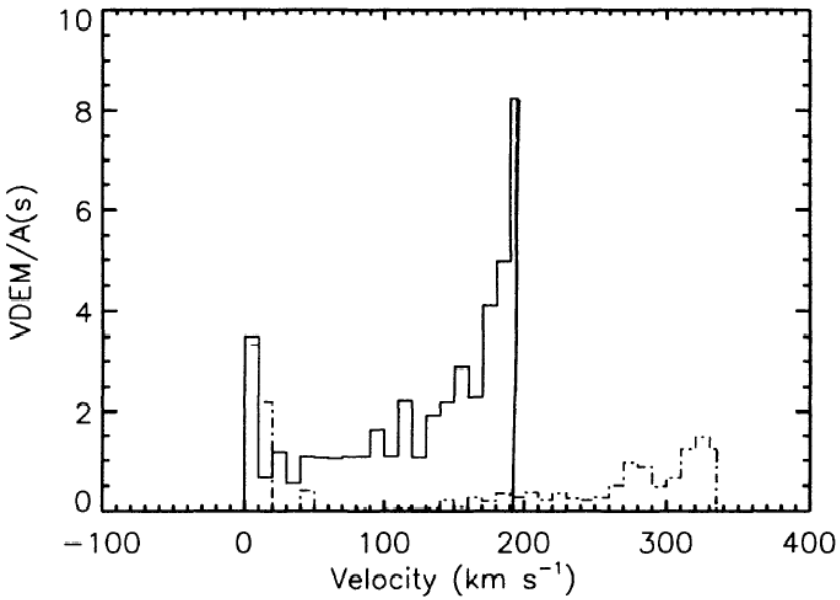
Velocity Differential Emission Measure (VDEM: Newton, Emslie, & Mariska 1995)

$$I(\lambda) = \frac{1}{4\pi D^2} \int VDEM(v) i_g(\lambda, v) dv$$

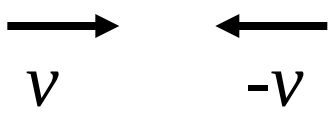
$$VDEM(v) = n_e{}^2 G(T) A(z) \frac{dz}{dv}$$

G(T): contribution function
A: projected area
z: distance from observer

$$i_g(\lambda, v) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{ \frac{-[\lambda - \lambda_0(1 - v/c)]^2}{2\sigma^2} \right\}$$

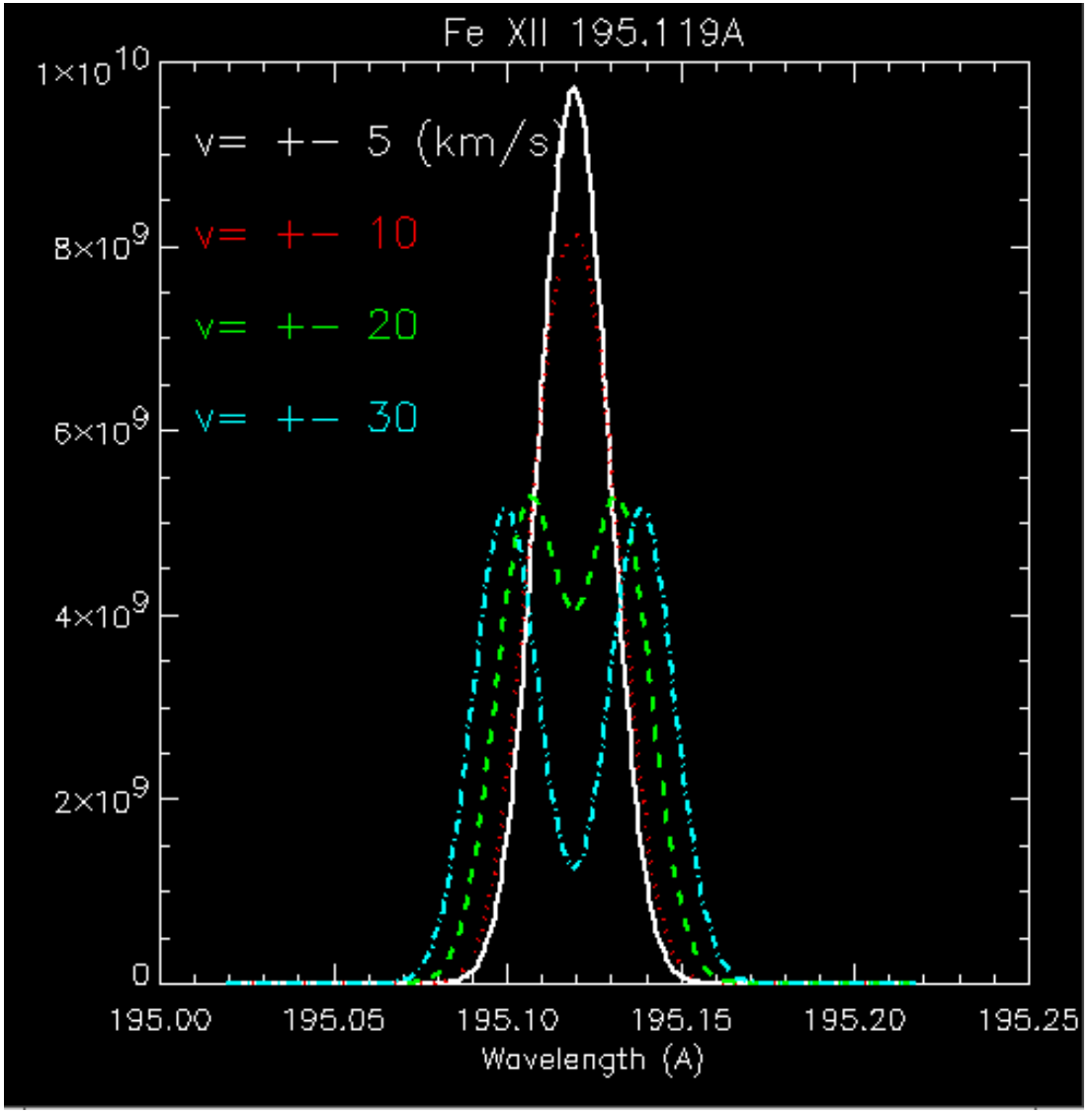


Cases of two gaussian components

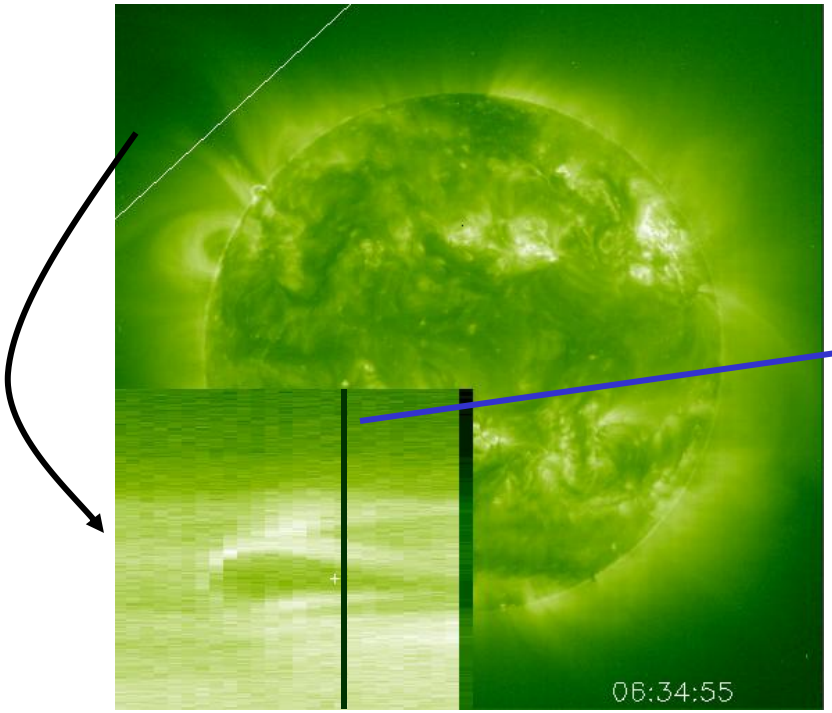


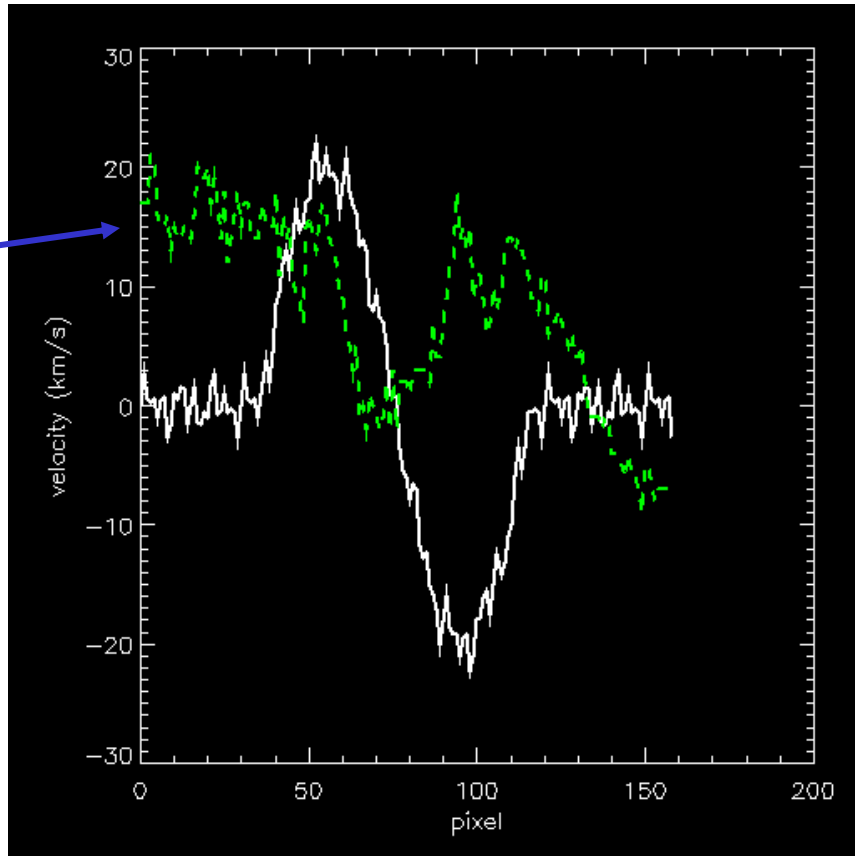
- 5 km/s is difficult to detect.
- 20-30 km seems OK.

T = 1.45 MK
No turbulence



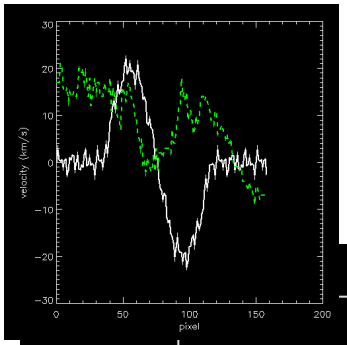
More realistic velocity distribution

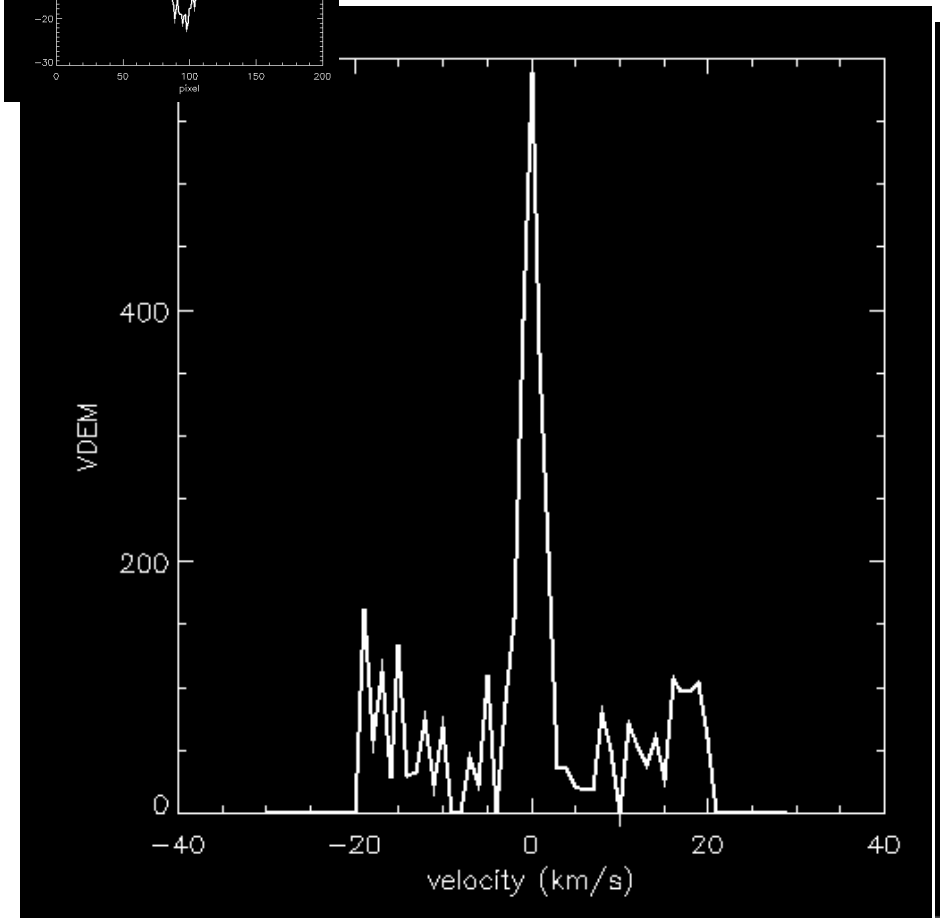




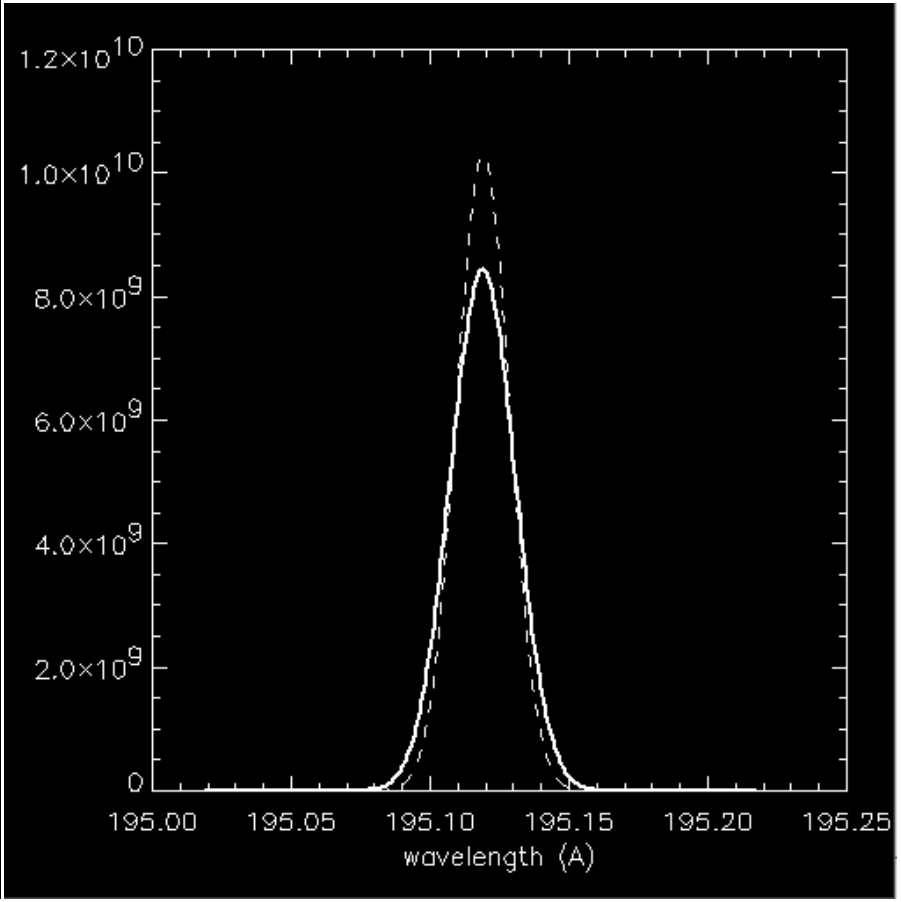
green: intensity distribution
white: assumed velocity distrition

Calculated VDEM and line profile



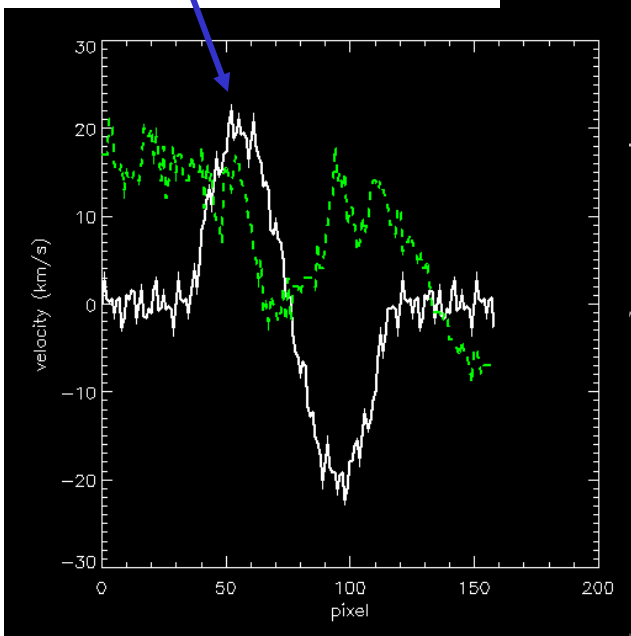


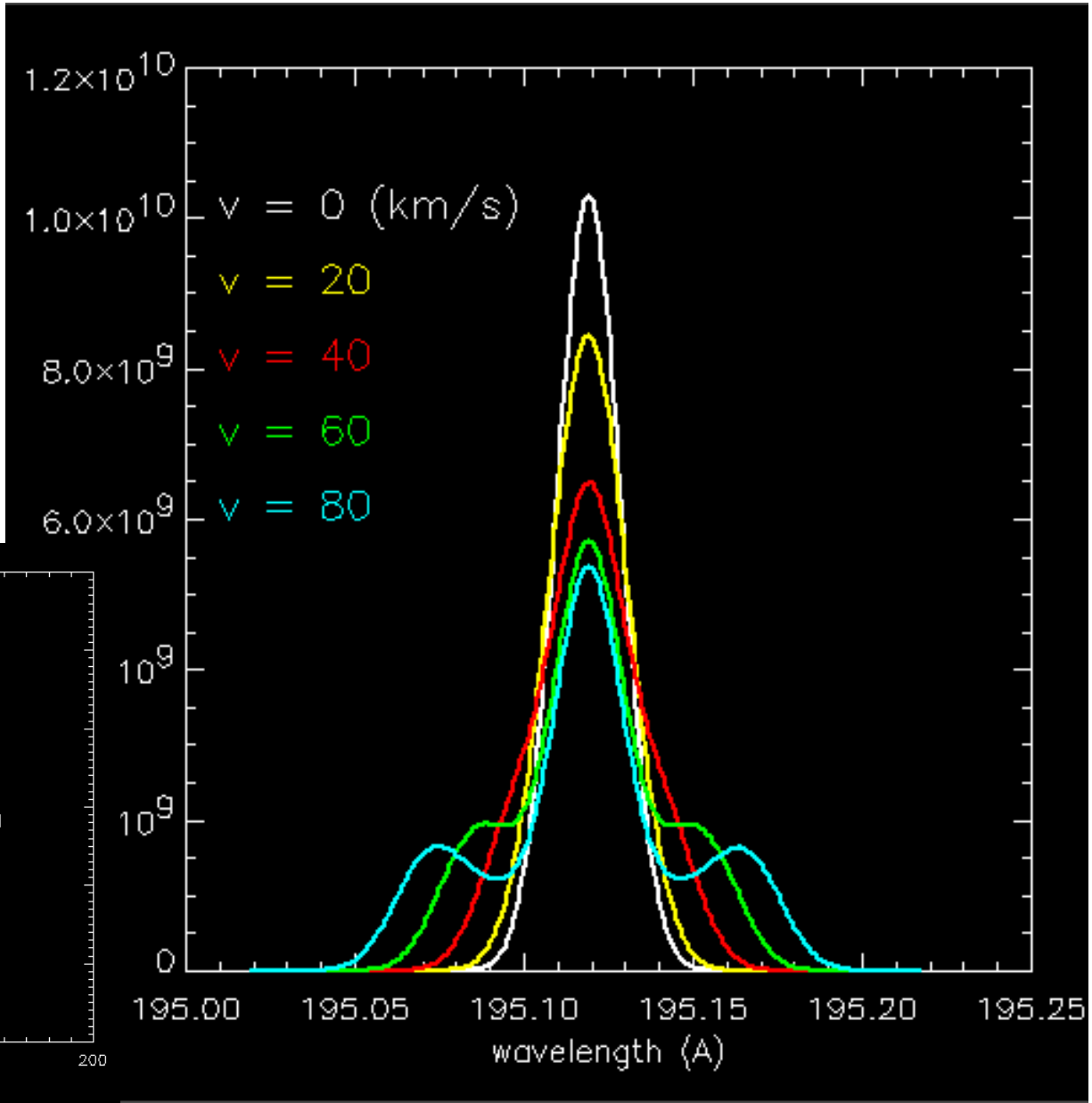
VDEM
(Maximum v = 20 km/s)



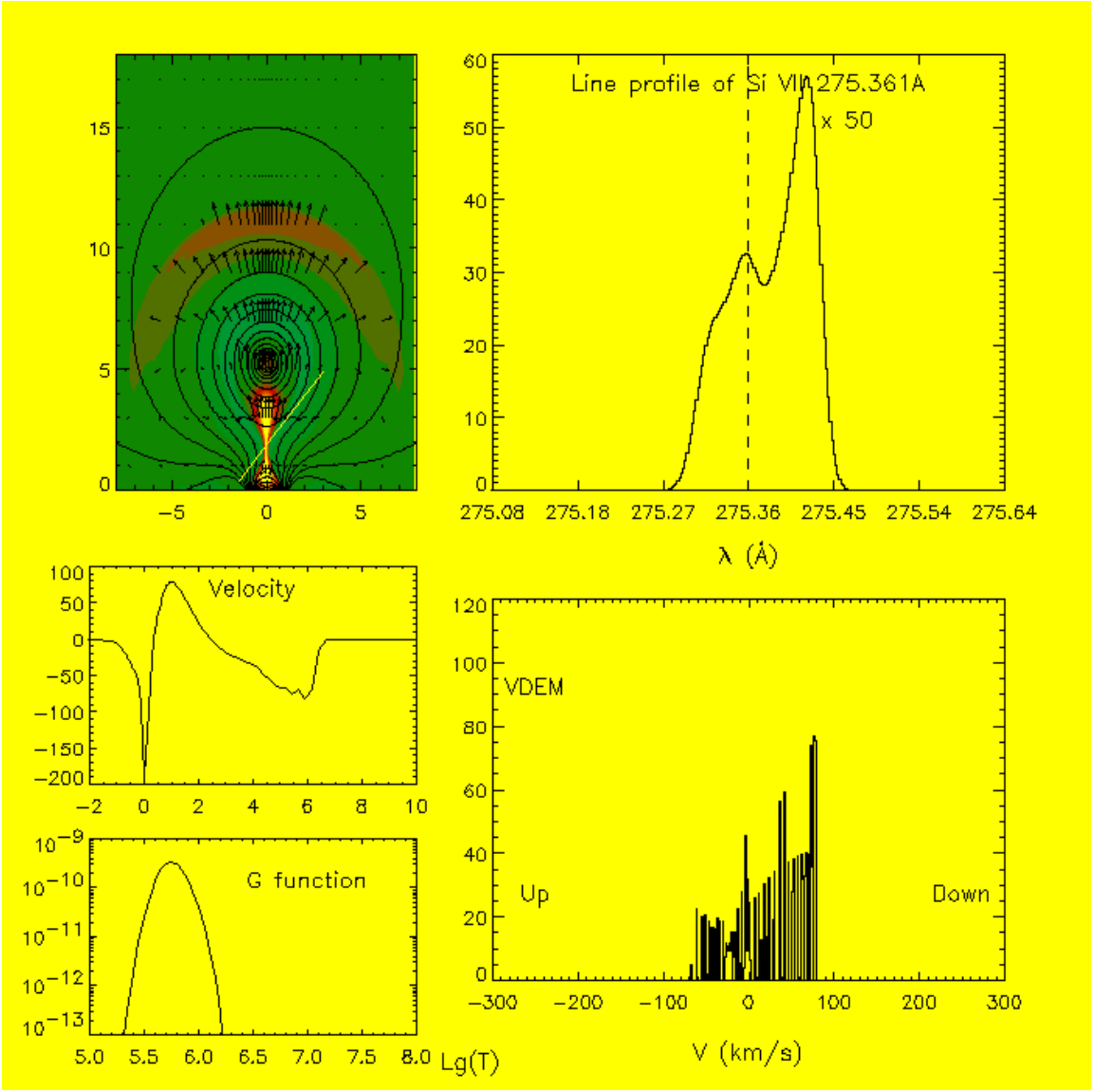
solid: line profile of calculated VDEM
dotted: single gaussian of v=0

Cases of
Max v = 0, 20,
40, 60, 80 km/s





Calculation of VDEM and line profile from MHD simulation



Conclusion

- Inflow region is dark. Signature of the inflows is easily masked by ambient plasma or nearby active regions on the line of sight.
- Analysis of VDEM and comparison with MHD modeling is important.

  => Chen-san's talk.